Part 27—Airworthiness Standards: Normal Category Rotorcraft

This change incorporates Amendment 27–33, Rotorcraft Regulatory Changes Based on European Joint Aviation Requirements, adopted May 2, and effective August 8, 1996. This amendment revises §§ 27.1, 27.65, and 27.1141, and adds § 27.1151 and Appendix C.

Bold brackets enclose the most recently changed or added material in these particular sections. The amendment number and effective date of new material appear in bold brackets at the end of each affected section.

Page Control Chart

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		Appendix C	Ch. 4

Suggest filing this transmittal at the beginning of the FAR. It will provide a method for determining that all changes have been received as listed in the current edition of AC 00–44, Status of Federal Aviation Regulations, and a check for determining if the FAR contains the proper pages.

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by Federal regulations. The RFA requires a Regulatory Flexibility Analysis if a rule has significant economic impact on a substantial number of small entities. FAA Order 2100.14A outlines FAA's procedures and criteria for implementing the RFA. The FAA has determined that this rule will not have a significant economic impact on a substantial number of small manufacturers or operators of rotorcraft because there are no small rotorcraft manufacturers, as that term is defined in the Order.

International Trade Impact Assessment

This rule will not constitute a barrier to international trade, including the export of American goods and services to foreign countries and the import of foreign goods and services into the United States. Each applicant for a new type certificate for a transport or normal category rotorcraft, whether the applicant be U.S. or foreign, will be required to show compliance with this rule. This rule will have no effect on the sale of U.S. rotorcraft in foreign markets and the sale of foreign rotorcraft in the United States.

Federalism Implications

The regulations adopted herein will not have substantial direct effects on the states, on the relationships between the national government and the states, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this regulation will not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

For the reasons stated above, including the findings of the Regulatory Flexibility Determination and the International Trade Impact Analysis, the FAA has determined that this regulation is not a significant regulatory action under Executive Order 12866. In addition, the FAA certifies that this regulation will not have a significant economic impact on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. This rule is not considered significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 26, 1979). A regulatory evaluation of this regulation, including a Regulatory Determination and Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under the section entitled "FOR FURTHER INFORMATION CONTACT."

The Amendments

Accordingly, the Federal Aviation Administration amends 14 CFR parts 27 and 29 of the Federal Aviation Regulations effective June 11, 1996.

The authority citation for part 27 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701–44702, 44704.

Amendment 27–33

Rotorcraft Regulatory Changes Based on European Joint Aviation Requirements

Adopted: May 2, 1996 **Effective: August 8, 1996**

(Published in 61 FR 21904, May 10, 1996)

SUMMARY: The Federal Aviation Administration (FAA) is amending the airworthiness standards for normal and transport category rotorcraft. The changes revise airworthiness standards for performance, systems, propulsion, and airframes. The changes increase the regulatory safety level, clarify existing regula-

Background

These amendments are based on Notice of Proposed Rulemaking (NPRM) No. 94–36 published in the *Federal Register* on December 28, 1994 (59 FR 67068). That notice proposed to amend the airworthiness standards for both normal and transport category rotorcraft based on recommendations from the Aviation Rulemaking Advisory Committee (ARAC). By announcement in the *Federal Register* (57 FR 58846, December 11, 1992), the "JAR/FAR 27 and 29 Harmonization Working Group" was chartered by the ARAC. The working group included representatives from four major rotorcraft manufacturers (normal and transport) and representatives from Aerospace Industries Association of America, Inc. (AIA), Association Europeene des Constructeurs de Material Aerospatial (AECMA), Helicopter Association International (HAI), JAA, and the FAA Rotorcraft Directorate. This broad participation is consistent with FAA policy to involve all known interested parties as early as practicable in the rulemaking process.

The Harmonization Working Group was tasked with making recommendations to the ARAC regarding JAA Notices of Proposed Amendment (NPA's). The ARAC subsequently recommended that the FAA revise the airworthiness standards for normal and transport category rotorcraft to those currently in the JAR 27 and 29.

The FAA evaluated the ARAC recommendations and proposed changes to the rotorcraft airworthiness standards in 14 CFR parts 27 and 29 (parts 27 and 29). These proposed changes evolved from the FAA, JAA, and industry meetings of 1990–1992 and the ARAC recommendations of 1993. The changes proposed to (1) incorporate current design and testing practices into the rules by requiring additional performance data, (2) incorporate additional powerplant and rotor brake controls requirements, (3) incorporate bird-strike protection requirements, and (4) harmonize the certification requirements between parts 27 and 29 and the JAR. The proposals for part 27 included JAA's harmonized NPA's 27—Basic and 27–1, and the proposals for part 29 included NPA's 29—Basic and 29–1 through 29–5. This rule contains the harmonized rule language of those sections of the NPA's except for § 27.602 of NPA 27—Basic and § 29.602 of NPA 29–4.

In proposed rule, NPRM 94–36, there were several instances in which a few descriptive words were proposed to either be removed from or added to regulatory text. These word changes were adequately described in the amendatory language to NPRM 94–36 when that proposal was published in the *Federal Register*. However, at least one commenter misunderstood the amendatory language. Therefore, to avoid possible misunderstanding about the final rule language, the paragraphs with the minor rule language changes are reproduced in their entirety in this final rule. Also, the numbering of other regulations referenced in §§ 29.1587(a)(4) and (a)(5) has been changed, and a new § 29.1587(a)(6) has been added. The current § 29.1587(a)(6), which is being redesignated in this rule as § 29.1587(a)(7), was added by the recently published Transport Category Rotorcraft Performance Rule published elsewhere in this issue of the *Federal Register*.

In this final rule, under the heading "Appendix C to Part 27—Criteria for Category A," the NPRM 94–36 cites to Advisory Circular (AC) material have been removed since AC material is advisory only. A note has been added that informs the reader that there is appropriate guidance material available. Further, the requirement to meet § 29.571 standards for certification as a part 27 Category A rotorcraft has been removed from the appendix C listing. The FAA has determined that the current § 27.571 contains sufficient certification standards to maintain an adequate level of safety for part 27 Category A rotorcraft, and an additional requirement of testing to § 29.571 standards is unnecessary.

Discussion of Comments

Interested persons have been afforded an opportunity to participate in the making of these amendments. Due consideration has been given to the comments received. Comments were received from the JAA, HAI, Transport Canada, and the United Kingdom Civil Aviation Authority (UKCAA).

The JAA agrees with the proposed rule and the effort to harmonize certification regulations of the U.S. and the European communities. To fulfill harmonization objectives, the JAA prepared an NPA interpretations. The commenter notes that the meaning of § 29.547 was changed because the word "main" had been removed in the ARAC recommendations but was not removed in the NPRM. This commenter also states that the requirements of §§ 29.547 and 29.917 are redundant because § 29.571 also requires the identification of the principal structural elements (PSE) that includes rotors and rotor drive systems with the establishment of the inspections and replacement times for those PSE's. Additionally, the commenter says that § 29.610 should state that it addresses only "direct effects" of lightning and electricity and that indirect effects are covered elsewhere in §§ 29.954, 29.863, 29.1309, etc. This commenter also states that § 29.1309 should retain the reference to § 29.610. This commenter also suggests adding a new requirement and paragraph to appendix B to part 29 that would require an additional, self-powered third attitude indicator.

The FAA agrees with Transport Canada that editorial changes between the ARAC recommendations and the NPRM are a concern because the differences may lead to different interpretations. To obviate this concern, editorial changes have been made in the final rule language to make it consistent with the ARAC recommended language. Also, the FAA agrees with Transport Canada that the word "main" had been removed from the introductory paragraph of § 29.547(c), (d), and (e) in the ARAC recommended language but, as previously discussed, had not been shown as removed in the NPRM rule language. However, the word "main" is being removed from this final rule.

The FAA does not agree with this commenter that §§ 29.547, 29.571, and 29.917 are redundant in requiring identification of principal structural elements (PSE's), which include rotors and rotor drive systems, and the establishment of the inspections, replacement times of those PSE's. Section 29.547(b) requires a design assessment for main and tail rotor structure components (rotor hub, blades, pitch control mechanisms, etc); § 29.571 requires fatigue evaluation of structural components; and § 29.917 requires a design assessment of the rotor drive system (drive shafts, transmission, gearboxes, etc). Therefore, these are not redundant requirements. The language is adopted as proposed.

The FAA agrees with the intent of this commenter's suggestion that § 29.610 should clearly indicate that it addresses only "direct effects" of lightning and electricity. However, this was achieved in the NPRM by adding the word "structure" between the words "rotorcraft" and "must" in § 29.610(a) to clarify that this paragraph applied to rotorcraft structure and not to systems and equipment. Accordingly, the language is adopted as proposed.

The FAA does not agree with this commenter that § 29.1309 should retain the reference to § 29.610. The NPRM added the word "structure" to § 29.610 to clarify that the paragraph applied to rotorcraft structure and not to systems and equipment. Since § 29.1309(h) applies to lightning protection of systems and equipment, it is inappropriate to reference § 29.610, which applies to lightning protection of structures. The commenter's proposal to retain the reference to § 29.610 is not adopted.

The FAA disagrees with this commenter's suggestion that a new requirement and paragraph be added to part 29, appendix B, to require an additional, self-powered third attitude indicator. Part 29, appendix B, paragraph VIII(a)(2) currently requires a standby attitude indicator that is independent of the aircraft electrical generating system. Additionally, part 29, appendix B, paragraph VIII(b)(5)(iii) states, "The equipment, systems, and installations must be designed so that one display of the information essential to the safety of flight that is provided by the instruments will remain available to a pilot, without additional crew-member action, after any single failure or combination of failures that is not shown to be extremely improbable . . . ." Currently, the only practical design to meet the extremely improbable (10^{-9}) requirement of part 29, appendix B, for the display of information essential to flight safety after a single failure or combination of failures is the design that uses a third attitude indicator powered by a source other than the aircraft electrical generating system. However, the FAA does not wish to limit future alternative designs that may meet the extremely improbable standard without a third attitude indicator. The suggestion of the commenter to add a requirement for a self-powered third attitude indicator is not adopted.

on a bench test, the test sequence must be conducted following stabilization at take-off power'' remains valid and the sentence should be retained in § 29.923(b)(3)(i). The sentence was adopted in Amendment 29–34 due to a commenter's statement that if the 5-minute takeoff power run to qualify the drive system is conducted as part of the endurance run, and the 30-second/2-minute OEI requirements are conducted on a bench test, then the takeoff power 5-minute run will be conducted twice on the same set of gears. The FAA did not intend to duplicate the takeoff power 5-minute run if the OEI requirements are conducted on a bench test, and the sentence was adopted for clarification. Since the omission of the sentence in NPRM 94–36 was inadvertent, since the reasons for including the sentence remain valid, and since the sentence is relieving in nature and does not place any additional burden on manufacturers, it is unnecessary to solicit prior public comment. Therefore, the sentence is restored as requested by the commenter.

After considering all of the comments, the FAA has determined that air safety and the pubic interest support adoption of the amendments with the changes noted.

Regulatory Evaluation Summary

Proposed changes to federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic effect of regulatory changes on small entities. Third, the Office of Management and Budget directs agencies to assess the effect of regulatory changes on international trade. In conducting these analyses, the FAA has determined that this rule: (1) would generate benefits that justify its costs and is not ''a significant regulatory action'' as defined in the Executive Order; (2) is nonsignificant as defined in DOT's Regulatory Policies and Procedures; (3) would not have a significant impact on substantial number of small entities; and (4) will lessen restraints on international trade. These analyses, available in the docket, are summarized below.

Cost-Benefit Analysis

All of the changes to part 27 and all but four of the changes to part 29 will impose no or insignificant costs on rotorcraft manufacturers since they largely reflect current design practices. In recent years, manufacturers have incorporated engineering and structural improvements into rotorcraft designs that exceed minimum regulatory requirements with the aim of increasing operating efficiencies, payload capabilities, and marketability in world markets. Many of these improvements have also inherently improved safety. Codification of these improvement and other changes will ensure continuation of enhanced safety levels in future rotorcraft designs.

The changes will also increase harmonization and commonality between U.S. and European airworthiness standards. Harmonization will eliminate the need to comply with different FAA and JAA airworthiness requirements, thus reducing manufacturers' certification costs. Based on experience in a recent certification, one rotorcraft manufacturer indicated that complying with different FAA and JAA requirements resulted in several hundred thousand dollars of excessive certification costs (as related to all part 27 and 29 requirements). The duplicate certification costs avoided by the harmonized rule alone could outweigh the relatively modest increase in certification costs imposed by the few new requirements. Following is a summary of the four changes to part 29 that will impose additional costs totaling approximately $160,000 per type certification. The safety benefits of these changes are expected to easily exceed the incremental costs.

Section 29.547—Main and tail rotor structure. While manufacturers currently perform the design assessment as an integral part of the design requirements of § 29.917, there will be some incremental costs to formalize the existing information. These costs are included in the cost estimates of § 29.917 summarized below. Formal identification and assessment of critical component failures will increase safety by providing more comprehensive maintenance information to operators. The benefits of averting a single accident will exceed the relatively low incremental costs of compliance.

Section 29.917—Design. The incremental costs to formalize existing design information for the rotor structure (§ 29.547 above) and drive system are estimated to total $47,000 per type certification. Formal identification and assessment of critical component failures of the rotor drive system will increase safety by providing more comprehensive maintenance information to operators. The benefits of averting a single accident caused directly or indirectly by a lack of relevant data would easily exceed the incremental costs.

Section 29.1587—Performance information. Since the required climb gradient data are already available from the results of flight tests required to obtain performance information, the only additional costs will be those associated with incorporating the data into the Flight Manual, estimated to total $6,000 per type certification. The availability and accuracy of performance data are paramount to operational safety. The benefits of averting a single accident caused directly or indirectly by a lack of relevant performance information will easily exceed the incremental costs.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by Federal Regulations. The RFA requires a Regulatory Flexibility Analysis if a proposed rule would have "a significant economic impact on a substantial number of small entities." Based on the criteria of FAA Order 2100.14A, the FAA has determined that the rule will not have a significant impact on a substantial number of small entities.

The rule will affect manufacturers of future type-certificated normal (part 27) and transport category (part 29) rotorcraft. For manufacturers, Order 2100.14A defines a small entity as one with 75 or fewer employees and a significant economic impact as annualized costs of $19,000 or more. The FAA has determined that the rule will not have a significant economic impact on a substantial number of small manufacturers since (1) no part 29 and only two part 27 rotorcraft manufacturers have 75 or fewer employees, and (2) the annualized certification costs of the rule are less than $19,000.

International Trade Impact Assessment

The rule will not constitute a barrier to international trade, including the export of American rotorcraft to other countries and the import of rotorcraft into the United States. Instead, the changes will harmonize with certification procedures of the JAA and thereby enhance free trade.

Conclusion

For the reasons discussed above, including the findings in the Regulatory Flexibility Determination and the International Trade Impact Analysis, the FAA has determined that this regulation is not a significant regulatory action under Executive Order 12866. In addition, the FAA certifies that this regulation will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. This regulation is considered nonsignificant under DOT Order 2100.5. A final regulatory evaluation of the regulation, including a final Regulatory Flexibility Determination and International Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under "FOR FURTHER INFORMATION CONTACT."

The Amendments

In consideration of the foregoing, the Federal Aviation Administration amends parts 27 and 29 of Title 14, Code of Federal Regulations (14 CFR parts 27 and 29) effective August 8, 1996.

The authority citation for part 27 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

Source: Docket No. 5074, 29 FR 15695, 11/24/64, unless otherwise noted.

§ 27.1 Applicability.

This part prescribes airworthiness standards for the issue of type certificates, and changes to those certificates, for normal category rotorcraft with maximum weights of 6,000 pounds or less.

(b) Each person who applies under part 21 for such a certificate or change must show compliance with the applicable requirements of this part.

[(c) Multiengine rotorcraft may be type certificated as Category A provided the requirements referenced in appendix C of this part are met.]

[(Amdt. 27–33, Eff. 8/8/96)]

§ 27.2 Special retroactive requirements.

[For each rotorcraft manufactured after September 16, 1992, each applicant must show that each occupant's seat is equipped with a safety belt and shoulder harness that meets the requirements of paragraphs (a), (b), and (c) of this section.

[(a) Each occupant's seat must have a combined safety belt and shoulder harness with a single-point release. Each pilot's combined safety belt and shoulder harness must allow each pilot, when seated with safety belt and shoulder harness fastened, to perform all functions necessary for flight operations. There must be a means to secure belts and harnesses, when not in use, to prevent interference with the operation of the rotorcraft and with rapid egress in an emergency.

[(b) Each occupant must be protected from serious head injury by a safety belt plus a shoulder harness that will prevent the head from contacting any injurious object.

[(c) The safety belt and shoulder harness must meet the static and dynamic strength requirements, if applicable, specified by the rotorcraft type certification basis.

[(d) For purposes of this section, the date of manufacture is either—

[(1) The date the inspection acceptance records, or equivalent, reflect that the rotorcraft is complete and meets the FAA-Approved Type Design Data; or

[(2) The date the foreign civil airworthiness authority certifies that the rotorcraft is complete and issues an original standard airworthiness certificate, or equivalent, in that country.]

[(Amdt. 27–28, Eff. 9/16/91)]

§ 27.21 Proof of compliance.

Each requirement of this subpart must be met at each appropriate combination of weight and center of gravity within the range of loading conditions for which certification is requested. This must be shown—

(a) By tests upon a rotorcraft of the type for which certification is requested, or by calculations based on, and equal in accuracy to, the results of testing; and

(b) By systematic investigation of each required combination of weight and center of gravity if compliance cannot be reasonably inferred from combinations investigated.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.25 Weight limits.

(a) *Maximum weight.* The maximum weight (the highest weight at which compliance with each applicable requirement of this part is shown) must be established so that it is—

(1) Not more than—

(i) The highest weight selected by the applicant;

(ii) The design maximum weight (the highest weight at which compliance with each applicable structural loading condition of this part is shown); or

(iii) The highest weight at which compliance with each applicable flight requirement of this part is shown; and

(2) Not less than the sum of—

(i) The empty weight determined under § 27.29;

(ii) The weight of usable fuel appropriate to the intended operation with full payload;

(iii) The weight of full oil capacity; and

(iv) For each seat, an occupant weight of 170 pounds or any lower weight for which certification is requested.

(b) *Minimum weight.* The minimum weight (the lowest weight at which compliance with each be established so that it is—

(1) Not more than the sum of—

(i) The empty weight determined under § 27.29; and

(ii) The weight of the minimum crew necessary to operate the rotorcraft, assuming for each crewmember a weight no more than 170 pounds, or any lower weight selected by the applicant, or included in the loading instructions; and

(2) Not less than—

(i) The lowest weight selected by the applicant;

(ii) The design minimum weight (the lowest weight at which compliance with each applicable structural loading condition of this part is shown); or

(iii) The lowest weight at which compliance with each applicable flight requirement of this part is shown.

(c) *Total weight with jettisonable external load.* A total weight for the rotorcraft with jettisonable external load attached that is greater than the maximum weight established under paragraph (a) of this section may be established if structural component approval for external load operations under part 133 of this chapter is requested and the following conditions are met:

(1) The portion of the total weight that is greater than the maximum weight established under paragraph (a) of this section is made up only of the weight of all or part of the jettisonable external load.

(2) Structural components of the rotorcraft are shown to comply with the applicable structural requirements of this part under the increased loads and stresses caused by the weight increase over that established under paragraph (a) of this section.

(3) Operation of the rotorcraft at a total weight greater than the maximum certificated weight established under paragraph (a) of this section is limited by appropriate operating limitations to

gravity must be established for each weight established under § 27.25. Such an extreme may not lie beyond—

(a) The extremes selected by the applicant;

(b) The extremes within which the structure is proven; or

(c) The extremes within which compliance with the applicable flight requirements is shown.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.29 Empty weight and corresponding center of gravity.

(a) The empty weight and corresponding center of gravity must be determined by weighing the rotorcraft without the crew and payload, but with—

(1) Fixed ballast;

(2) Unusable fuel; and

(3) Full operating fluids, including—

(i) Oil;

(ii) Hydraulic fluid; and

(iii) Other fluids required for normal operation of rotorcraft systems, except water intended for injection in the engines.

(b) The condition of the rotorcraft at the time of determining empty weight must be one that is well defined and can be easily repeated, particularly with respect to the weights of fuel, oil, coolant, and installed equipment.

(Amdt. 27–14, Eff. 3/1/78)

§ 27.31 Removable ballast.

Removable ballast may be used in showing compliance with the flight requirements of this subpart.

§ 27.33 Main rotor speed and pitch limits.

(a) *Main rotor speed limits.* A range of main rotor speeds must be established that—

(1) With power on, provides adequate margin to accommodate the variations in rotor speed occurring in any appropriate maneuver, and is consistent with the kind of governor or synchronizer used; and

maximum limitations, that main rotor speeds substantially less than the minimum approved main rotor speed will not occur under any sustained flight condition. This must be met by—

(1) Appropriate setting of the main rotor high pitch stop;

(2) Inherent rotorcraft characteristics that make unsafe low main rotor speeds unlikely; or

(3) Adequate means to warn the pilot of unsafe main rotor speeds.

(c) *Normal main rotor low pitch limits (power off).* It must be shown, with power off, that—

(1) The normal main rotor low pitch limit provides sufficient rotor speed, in any autorotative condition, under the most critical combinations of weight and airspeed; and

(2) It is possible to prevent overspeeding of the rotor without exceptional piloting skill.

(d) *Emergency high pitch.* If the main rotor high pitch stop is set to meet paragraph (b)(1) of this section, and if that stop cannot be exceeded inadvertently, additional pitch may be made available for emergency use.

(e) *Main rotor low speed warning for helicopters.* For each single engine helicopter, and each multiengine helicopter that does not have an approved device that automatically increases power on the operating engines when one engine fails, there must be a main rotor low speed warning which meets the following requirements:

(1) The warning must be furnished to the pilot in all flight conditions, including power-on and power-off flights, when the speed of a main rotor approaches a value that can jeopardize safe flight.

(2) The warning may be furnished either through the inherent aerodynamic qualities of the helicopter or by a device.

(3) The warning must be clear and distinct under all conditions, and must be clearly distinguishable from all other warnings. A visual device that requires the attention of the crew within the cockpit is not acceptable by itself.

(4) If a warning device is used, the device must automatically deactivate and reset when the low-speed condition is corrected. If the device

§ 27.45 General.

(a) Unless otherwise prescribed, the performance requirements of this subpart must be met for still air and a standard atmosphere.

(b) The performance must correspond to the engine power available under the particular ambient atmospheric conditions, the particular flight condition, and the relative humidity specified in paragraphs (d) or (e) of this section, as appropriate.

(c) The available power must correspond to engine power, not exceeding the approved power, less—

(1) Installation losses; and

(2) The power absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

(d) For reciprocating engine-powered rotorcraft, the performance, as affected by engine power, must be based on a relative humidity of 80 percent in a standard atmosphere.

(e) For turbine engine-powered rotorcraft, the performance, as affected by engine power, must be based on a relative humidity of—

(1) 80 percent, at and below standard temperature; and

(2) 34 percent, at and above standard temperature plus 50 degrees F. Between these two temperatures, the relevant humidity must vary linearly.

(f) For turbine-engine-powered rotorcraft, a means must be provided to permit the pilot to determine prior to takeoff that each engine is capable of developing the power necessary to achieve the applicable rotorcraft performance prescribed in this subpart.

(Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–21, Eff. 12/6/84)

§ 27.51 Takeoff.

(a) The takeoff, with takeoff power and r.p.m., and with the extreme forward center of gravity—

craft, or 7,000 feet, whichever is less; and

(2) Weight, from the maximum weight at sea level) to each lesser weight selected by the applicant for each altitude covered by paragraph (b)(1) of this section.

§ 27.65 Climb: All engines operating.

(a) For rotorcraft other than helicopters—

(1) The steady rate of climb, at V_Y, must be determined—

(i) With maximum continuous power on each engine;

(ii) With the landing gear retracted; and

(iii) For the weights, altitudes, and temperatures for which certification is requested; and

(2) [The steady rate of climb must be determined—]

(i) At least 1:10 if the horizontal distance required to take off and climb over a 50-foot obstacle is determined for each weight, altitude, and temperature within the range for which certification is requested; or

(ii) [Within the range from sea level up to the maximum altitude for which certification is requested;]

(b) Each helicopter must meet the following requirements:

(1) V_Y must be determined—

(i) For standard sea level conditions;

(ii) At maximum weight; and

(iii) With maximum continuous power on each engine.

(2) If at any altitude within the range for which certification is requested, V_{NE} is less than V_Y the steady rate of climb must be determined—

(i) At the climb speed selected by the applicant at or below V_{NE};

(ii) Within the range from 2,000 feet below the altitude at which V_{NE} is equal to V_Y up to the maximum altitude for which certification is requested;

(iii) For the weights and temperature that correspond to the altitude range set forth in

For multiengine helicopters, the steady rate of climb (or descent), at V_Y (or at the speed for minimum rate of descent), must be determined with—

(a) Maximum weight;

(b) The critical engine inoperative and the remaining engines at either—

(1) Maximum continuous power and, for helicopters for which certification for the use of 30-minute OEI power is requested, at 30-minute OEI power; or

(2) Continuous OEI power for helicopters for which certification for the use of continuous OEI power is requested.

(Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–23, Eff. 10/3/88)

§ 27.71 Glide performance.

For single-engine helicopters and multi-engine helicopters that do not meet the Category A engine isolation requirements of part 29 of this chapter, the minimum rate of descent airspeed and the best angle-of-glide airspeed must be determined in autorotation at—

(a) Maximum weight; and

(b) Rotor speed(s) selected by the applicant.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.73 Performance at minimum operating speed.

(a) For helicopters—

(1) The hovering ceiling must be determined over the ranges of weight, altitude, and temperature for which certification is requested, with—

(i) Takeoff power;

(ii) The landing gear extended; and

(iii) The helicopter in ground effect at a height consistent with normal takeoff procedures; and

(2) The hovering ceiling determined under paragraph (a)(1) of this section must be at least—

(i) For reciprocating engine powered helicopters, 4,000 feet at maximum weight with a standard atmosphere; or

(2) The landing gear extended.

§ 27.75 Landing.

(a) The rotorcraft must be able to be landed with no excessive vertical acceleration, no tendency to bounce, nose over, ground loop, porpoise, or water loop, and without exceptional piloting skill or exceptionally favorable conditions, with—

(1) Approach or glide speeds appropriate to the type of rotorcraft and selected by the applicant;

(2) The approach and landing made with—

(i) Power off, for single-engine rotorcraft; and

(ii) For multiengine rotorcraft, one engine inoperative and with each operating engine within approved operating limitations; and

(3) The approach and landing entered from steady autorotation.

(b) Multiengine rotorcraft must be able to be landed safely after complete power failure under normal operating conditions.

(Amdt. 27–14, Eff. 3/1/78)

§ 27.79 Limiting height-speed envelope.

(a) If there is any combination of height and forward speed (including hover) under which a safe landing cannot be made under the applicable power failure condition in paragraph (b) of this section, a limiting height-speed envelope must be established (including all pertinent information) for that condition, throughout the ranges of—

(1) Altitude, from standard sea level conditions to the maximum altitude capability of the rotorcraft, or 7,000 feet, whichever is less; and

(2) Weight, from the maximum weight (at sea level) to the lesser weight selected by the applicant for each altitude covered by paragraph (a)(1) of this section. For helicopters, the weight at altitudes above sea level may not be less than the maximum weight or the highest weight allowing hovering out of ground effect, whichever is less.

(b) The applicable power failure conditions are—

(3) For other rotorcraft, conditions appropriate to the type.

(Amdt. 27–16, Eff. 12/1/78); (Amdt. 27–21, Eff. 12/6/84)

FLIGHT CHARACTERISTICS

§ 27.141 General.

The rotorcraft must—

(a) Except as specifically required in the applicable section, meet the flight characteristics requirements of this subpart—

(1) At the altitudes and temperatures expected in operation;

(2) Under any critical loading condition within the range of weights and centers of gravity for which certification is requested;

(3) For power-on operations, under any condition of speed, power, and rotor r.p.m. for which certification is requested; and

(4) For power-off operations, under any condition of speed and rotor r.p.m. for which certification is requested that is attainable with the controls rigged in accordance with the approved rigging instructions and tolerances;

(b) Be able to maintain any required flight condition and make a smooth transition from any flight condition to any other flight condition without exceptional piloting skill, alertness, or strength, and without danger of exceeding the limit load factor under any operating condition probable for the type, including—

(1) Sudden failure of one engine, for multiengine rotorcraft meeting transport category A engine isolation requirements of part 29 of this chapter; and

(2) Sudden, complete power failure for other rotorcraft;

(3) Sudden, complete control system failures specified in § 27.695 of this part; and

(c) Have any additional characteristic required for night or instrument operation, if certification for those kinds of operation is requested. Require-

maneuverable—

(1) During steady flight; and

(2) During any maneuver appropriate to the type including—

(i) Takeoff;

(ii) Climb;

(iii) Level flight;

(iv) Turning flight;

(v) Glide;

(vi) Landing (power on and power off); and

(vii) Recovery to power-on flight from a balked autorotative approach.

(b) The margin of cyclic control must allow satisfactory roll and pitch control at V_{NE} with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Critical rotor r.p.m.; and

(4) Power off (except for helicopters demonstrating compliance with paragraph (e) of this section) and power on.

(c) A wind velocity of not less than 17 knots must be established in which the rotorcraft can be operated without loss of control on or near the ground in any maneuver appropriate to the type (such as crosswind takeoffs, sideward flight, and rearward flight), with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Critical rotor r.p.m.; and

(4) Altitude, from standard sea level conditions to the maximum altitude capability of the rotorcraft or 7,000 feet, whichever is less.

(d) The rotorcraft, after (1) failure of one engine in the case of multiengine rotorcraft that meet transport category A engine isolation requirements, or (2) complete engine failure in the case of other rotorcraft, must be controllable over the range of speeds and altitudes for which certification is requested when such power failure occurs with maximum continuous power and critical weight. No corrective action time delay for any condition following power failure may be less than—

(i) For the cruise condition, one second, or normal pilot reaction time (whichever is greater); and after the last operating engine is made inoperative at power-on V_{NE}.

(2) At a speed of 1.1 V_{NE} (power-off), the margin of cyclic control must allow satisfactory roll and pitch control with power off.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–14, Eff. 3/1/78); (Amdt. 27–21, Eff. 12/6/84)

§ 27.151 Flight controls.

(a) Longitudinal, lateral, directional, and collective controls may not exhibit excessive breakout force, friction, or preload.

(b) Control system forces and free play may not inhibit a smooth, direct rotorcraft response to control system input.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.161 Trim control.

The trim control—

(a) Must trim any steady longitudinal, lateral, and collective control forces to zero in level flight at any appropriate speed; and

(b) May not introduce any undesirable discontinuities in control force gradients.

(Amdt. 27–21, Eff. 12/6/84)

§ 27.171 Stability: General.

The rotorcraft must be able to be flown, without undue pilot fatigue or strain, in any normal maneuver for a period of time as long as that expected in normal operation. At least three landings and takeoffs must be made during this demonstration.

§ 27.173 Static longitudinal stability.

(a) The longitudinal control must be designed so that a rearward movement of the control is necessary to obtain a speed less than the trim speed, and a forward movement of the control is necessary to obtain a speed more than the trim speed.

(b) With the throttle and collective pitch held constant during the maneuvers specified in § 27.175(a) through (c), the slope of the control position versus speed curve must be positive

§ 27.175 Demonstration of static longitudinal stability.

(a) *Climb.* Static longitudinal stability must be shown in the climb condition at speeds from 0.85 V_Y to 1.2 V_Y, with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Maximum continuous power;

(4) The landing gear retracted; and

(5) The rotorcraft trimmed at V_Y.

(b) *Cruise.* Static longitudinal stability must be shown in the cruise condition at speeds from 0.7 V_H or 0.7 VNE, whichever is less, to 1.1 V_H or 1.1 V_{NE}, whichever is less, with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Power for level flight at 0.9 V_H or 0.9 V_{NE}, whichever is less;

(4) The landing gear retracted; and

(5) The rotorcraft trimmed at 0.9 V_H or 0.9 V_{NE}, whichever is less.

(c) *Autorotation.* Static longitudinal stability must be shown in autorotation at airspeeds from 0.5 times the speed for minimum rate of descent to V_{NE}, or to 1.1 V_{NE} (power-off) if V_{NE} (power-off) is established under § 27.1505(c), and with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Power off;

(4) The landing gear—

(i) Retracted; and

(ii) Extended; and

(5) The rotorcraft trimmed at appropriate speeds found necessary by the Administrator to demonstrate stability throughout the prescribed speed range.

(d) *Hovering.* For helicopters, the longitudinal cyclic control must operate with the sense and direction of motion prescribed in § 27.173 between the maximum approved rearward speed and a forward speed of 17 knots with—

(1) Critical weight;

§ 27.177 Static directional stability.

Static directional stability must be positive with throttle and collective controls held constant at the trim conditions specified in § 27.175(a) and (b). This must be shown by steadily increasing directional control deflection for sideslip angles up to ±10° from trim. Sufficient cues must accompany sideslip to alert the pilot when approaching sideslip limits.

(Amdt. 27–21, Eff. 12/6/84)

GROUND AND WATER HANDLING CHARACTERISTICS

§ 27.231 General.

The rotorcraft must have satisfactory ground and water handling characteristics, including freedom

§ 27.239 Spray characteristics.

If certification for water operation is requested, no spray characteristics during taxiing, takeoff, or landing may obscure the vision of the pilot or damage the rotors, propellers, or other parts of the rotorcraft.

§ 27.241 Ground resonance.

The rotorcraft may have no dangerous tendency to oscillate on the ground with the rotor turning.

MISCELLANEOUS FLIGHT REQUIREMENTS

§ 27.251 Vibration.

Each part of the rotorcraft must be free from excessive vibration under each appropriate speed and power condition.

GENERAL

§ 27.901 Installation.

(a) For the purpose of this part, the powerplant installation includes each part of the rotorcraft (other than the main and auxiliary rotor structures) that—

(1) Is necessary for propulsion;

(2) Affects the control of the major propulsive units; or

(3) Affects the safety of the major propulsive units between normal inspections or overhauls.

(b) For each powerplant installation—

(1) [Each component of the installation must be constructed, arranged, and installed to ensure its continued safe operation between normal inspections or overhauls for the range of temperature and altitude for which approval is requested;]

(2) Accessibility must be provided to allow any inspection and maintenance necessary for continued airworthiness;

(3) Electrical interconnections must be provided to prevent differences of potential between major components of the installation and the rest of the rotorcraft;

(4) Axial and radial expansion of turbine engines may not affect the safety of the installation; and

[(5) Design precautions must be taken to minimize the possibility of incorrect assembly of components and equipment essential to safe operation of the rotorcraft, except where operation which the incorrect assembly can be shown to be extremely improbable.]

(c) The installation must comply with—

(1) The installation instructions provided under § 33.5 of this chapter; and

(2) The applicable provisions of this subpart.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–23, Eff. 10/3/88)

§ 27.903 Engines.

(a) *Engine type certification.* [Each engine must have an approved type certificate. Reciprocating engines for use in helicopters must be qualified in accordance with § 33.49(d) of this chapter or be otherwise approved for the intended usage.]

(b) [*Engine or drive system cooling fan blade protection.*]

[(1) If an engine or rotor drive system cooling fan is installed, there must be means to protect the rotorcraft and allow a safe landing if a fan blade fails. This must be shown by showing that—

[(i) The fan blades are contained in case of failure;

[(ii) Each fan is located so that a failure will not jeopardize safety; or

[(iii) Each fan blade can withstand an ultimate load of 1.5 times the centrifugal force resulting from operation limited by the following:

[(A) For fans driven directly by the engine—

[(*1*) The terminal engine r.p.m. under uncontrolled conditions; or

[(*2*) An overspeed limiting device.

[(B) For fans driven by the rotor drive system, the maximum rotor drive system rotational speed to be expected in service, including transients.

[(2) Unless a fatigue evaluation under § 27.571 is conducted, it must be shown that cooling fan blades are not operating at resonant conditions within the operating limits of the rotorcraft.]

(c) *Turbine engine installation.* For turbine engine installations, the powerplant systems associated with engine control devices, systems, and instrumentation must be designed to give reasonable assurance that those engine operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–20, Eff. 3/26/84); (Amdt. 27–23, Eff. 10/3/88)

(c) No part of the rotor drive system may be subjected to excessive vibration stresses.

ROTOR DRIVE SYSTEM

§ 27.917 Design.

(a) Each rotor drive system must incorporate a unit for each engine to automatically disengage that engine from the main and auxiliary rotors if that engine fails.

(b) Each rotor drive system must be arranged so that each rotor necessary for control in autorotation will continue to be driven by the main rotors after disengagement of the engine from the main and auxiliary rotors.

(c) If a torque limiting device is used in the rotor drive system, it must be located so as to allow continued control of the rotorcraft when the device is operating.

(d) The rotor drive system includes any part necessary to transmit power from the engines to the rotor hubs. This includes gear boxes, shafting, universal joints, couplings, rotor brake assemblies, clutches, supporting bearings for shafting, any attendant accessory pads or drives, and any cooling fans that are a part of, attached to, or mounted on the rotor drive system.

(Amdt. 27–11, Eff. 2/1/77)

§ 27.921 Rotor brake.

If there is a means to control the rotation of the rotor drive system independently of the engine, any limitations on the use of that means must be specified, and the control for that means must be guarded to prevent inadvertent operation.

§ 27.923 Rotor drive system and control mechanism tests.

(a) Each part tested as prescribed in this section must be in a serviceable condition at the end of the tests. No intervening disassembly which might affect test results may be conducted.

(c) A 60-hour part of the test prescribed in paragraph (b) of this section must be run at not less than maximum continuous torque and the maximum speed for use with maximum continuous torque. In this test, the main rotor controls must be set in the position that will give maximum longitudinal cyclic pitch change to simulate forward flight. The auxiliary rotor controls must be in the position for normal operation under the conditions of the test.

(d) A 30-hour or, for rotorcraft for which the use of either 30-minute OEI power or continuous OEI power is requested, a 25-hour part of the test prescribed in paragraph (b) of this section must be run at not less than 75 percent of maximum continuous torque and the minimum speed for use with 75 percent of maximum continuous torque. The main and auxiliary rotor controls must be in the position for normal operation under the conditions of the test.

(e) [A 10-hour part of the test prescribed in paragraph (b) of this section must be run at not less than takeoff torque and the maximum speed for use with takeoff torque. The main and auxiliary rotor controls must be in the normal position for vertical ascent.

[(1) For multiengine rotorcraft for which the use of 2 1/2-minute OEI power is requested, 12 runs during the 10-hour test must be conducted as follows:

[(i) Each run must consist of at least one period of 2 1/2 minutes with takeoff torque and the maximum speed for use with takeoff torque on all engines.

[(ii) Each run must consist of at least one period for each engine in sequence, during which that engine simulates a power failure and the remaining engines are run at 2 1/2-minute OEI torque and the maximum speed for use with 2 1/2-minute OEI torque for 2 1/2 minutes.

[(2) For multiengine, turbine-powered rotorcraft for which the use of 30-second and 2-minute OEI power is requested, 10 runs must be conducted as follows:

[(i) Immediately following a takeoff run of at least 5 minutes, each power source must condition. When conducted on a bench test, the test sequence must be conducted following stabilization at takeoff power.

[(ii) For the purpose of this paragraph, an affected power input includes all parts of the rotor drive system which can be adversely affected by the application of higher or asymmetric torque and speed prescribed by the test.

[(iii) This test may be conducted on a representative bench test facility when engine limitations either preclude repeated use of this power or would result in premature engine removal during the test. The loads, the vibration frequency, and the methods of application to the affected rotor drive system components must be representative of rotorcraft conditions. Test components must be those used to show compliance with the remainder of this section.]

(f) The parts of the test prescribed in paragraphs (c) and (d) of this section must be conducted in intervals of not less than 30 minutes and may be accomplished either on the ground or in flight. The part of the test prescribed in paragraph (e) of this section must be conducted in intervals of not less than 5 minutes.

(g) At intervals of not more than 5 hours during the tests prescribed in paragraphs (c) (d), and (e) of this section, the engine must be stopped rapidly enough to allow the engine and rotor drive to be automatically disengaged from the rotors.

(h) Under the operating conditions specified in paragraph (c) of this section, 500 complete cycles of lateral control, 500 complete cycles of longitudinal control of the main rotors, and 500 complete cycles of control of each auxiliary rotor must be accomplished. A "complete cycle" involves movement of the controls from the neutral position, through both extreme positions, and back to the neutral position, except that control movements need not produce loads or flapping motions exceeding the maximum loads or motions encountered in flight. The cycling may be accomplished during the testing prescribed in paragraph (c) of this section.

(i) At least 200 start-up clutch engagements must be accomplished—

ative and the remaining engine(s) is run for a 30-minute period.

(k) For multiengine rotorcraft for which the use of continuous OEI power is requested, five runs must be made at continuous OEI torque and the maximum speed for use with continuous OEI torque, in which each engine, in sequence, is made inoperative and the remaining engine(s) is run for a 1-hour period.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–23, Eff. 10/3/88); [(Amdt. 27–29, Eff. 10/17/94)]

§ 27.927 Additional tests.

(a) Any additional dynamic, endurance, and operational tests, and vibratory investigations necessary to determine that the rotor drive mechanism is safe, must be performed.

(b) If turbine engine torque output to the transition can exceed the highest engine or transmission torque rating limit, and that output is not directly controlled by the pilot under normal operating conditions (such as where the primary engine power control is accomplished through the flight control), the following test must be made:

(1) Under conditions associated with all engines operating, make 200 applications, for 10 seconds each, of torque that is at least equal to the lesser of—

(i) The maximum torque used in meeting § 27.923 plus 10 percent; or

(ii) The maximum attainable torque output of the engines, assuming that torque limiting devices, if, any, function properly.

(2) For multiengine rotorcraft under conditions associated with each engine, in turn, becoming inoperative, apply to the remaining transmission torque inputs the maximum torque attainable under probable operating conditions, assuming that torque limiting devices, if, any, function properly. Each transmission input must be tested at this maximum torque for at least 15 minutes.

(3) [The tests prescribed in this paragraph must be conducted on the rotorcraft at the maximum rotational speed intended for the power

tive conditions for 15 minutes after the loss of pressure in the rotor drive primary oil system.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–23, Eff. 10/3/88)

§ 27.931 Shafting critical speed.

(a) The critical speeds of any shafting must be determined by demonstration, except that analytical methods may be used if reliable methods of analysis are available for the particular design.

(b) If any critical speed lies within, or close to, the operating ranges for idling, power on, and autorotative conditions, the stresses occurring at that speed must be within safe limits. This must be shown by tests.

(c) If analytical methods are used and show that no critical speed lies within the permissible operating ranges, the margins between the calculated critical speeds and the limits of the allowable operating ranges must be adequate to allow for possible variations between the computed and actual values.

§ 27.935 Shafting joints.

Each universal joint, slip joint, and other shafting joints whose lubrication is necessary for operation must have provision for lubrication.

§ 27.939 Turbine engine operating characteristics.

(a) Turbine engine operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present, to a hazardous degree, during normal and emergency operation within the range of operating limitations of the rotorcraft and the engine.

(b) The turbine engine air inlet system may not, as a result of airflow distortion during normal operation, cause vibration harmful to the engine.

(c) For governor-controlled engines, it must be shown that there exists no hazardous torsional instability of the drive system associated with criti-

(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper engine functioning under any likely operating condition, including the maneuvers for which certification is requested.

(b) Each fuel system must be arranged so that—

(1) No fuel pump can draw fuel from more than one tank at a time; or

(2) There are means to prevent introducing air into the system.

(c) Each fuel system for a turbine engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80°F and having 0.75cc of free water per gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

(Amdt. 27–9, Eff. 10/31/74)

[§ 27.952 Fuel system crash resistance.

[Unless other means acceptable to the Administrator are employed to minimize the hazard of fuel fires to occupants following an otherwise survivable impact (crash landing), the fuel systems must incorporate the design features of this section. These systems must be shown to be capable of sustaining the static and dynamic deceleration loads of this section, considered as ultimate loads acting alone, measured at the system component's center of gravity, without structural damage to system components, fuel tanks, or their attachments that would leak fuel to an ignition source.

(a) *Drop test requirements.* Each tank, or the most critical tank, must be drop-tested as follows:

(1) The drop height must be at least 50 feet.

(2) The drop impact surface must be nondeforming.

(3) The tank must be filled with water to 80 percent of the normal, full capacity.

(4) The tank must be enclosed in a surrounding structure representative of the installation unless it can be established that the surrounding structure is free of projections or other design features likely to contribute to rupture of the tank.

designed and installed to retain its contents under the following ultimate inertial load factors, acting alone.

(1) For fuel tanks in the cabin:

(i) Upward—4g.

(ii) Forward—16g.

(iii) Sideward—8g.

(iv) Downward—20g.

(2) For fuel tanks located above or behind the crew or passenger compartment that, if loosened, could injure an occupant in an emergency landing:

(i) Upward—1.5g.

(ii) Forward—8g.

(iii) Sideward—2g.

(iv) Downward - 4g.

(3) For fuel tanks in other areas:

(i) Upward - 1.5g.

(ii) Forward - 4g.

(iii) Sideward - 2g.

(iv) Downward - 4g.

(c) *Fuel line self-sealing breakaway couplings.* Self-sealing breakaway couplings must be installed unless hazardous relative motion of fuel system components to each other or to local rotorcraft structure is demonstrated to be extremely improbable or unless other means are provided. The couplings or equivalent devices must be installed at all fuel tank-to-fuel line connections, tank-to-tank interconnects, and at other points in the fuel system where local structural deformation could lead to the release of fuel.

(1) The design and construction of self-sealing breakaway couplings must incorporate the following design features:

(i) The load necessary to separate a breakaway coupling must be between 25 to 50 percent of the minimum ultimate failure load (ultimate strength) of the weakest component in the fluid-carrying line. The separation load must in no case be less than 300 pounds, regardless of the size of the fluid line.

(ii) A breakaway coupling must separate whenever its ultimate load (as defined in para-

or unintended closing due to operational shocks, vibrations, or accelerations.

(v) No breakaway coupling design may allow the release of fuel once the coupling has performed its intended function.

(2) All individual breakaway couplings, coupling fuel feed systems, or equivalent means must be designed, tested, installed, and maintained so that inadvertent fuel shutoff in flight is improbable in accordance with § 27.955(a) and must comply with the fatigue evaluation requirements of § 27.571 without leaking.

(3) Alternate, equivalent means to the use of breakaway couplings must not create a survivable impact-induced load on the fuel line to which it is installed greater than 25 to 50 percent of the ultimate load (strength) of the weakest component in the line and must comply with the fatigue requirements of § 27.571 without leaking.

(d) *Frangible or deformable structural attachments.* Unless hazardous relative motion of fuel tanks and fuel system components to local rotorcraft structure is demonstrated to be extremely improbable in an otherwise survivable impact, frangible or locally deformable attachments of fuel tanks and fuel system components to local rotorcraft structure must be used. The attachment of fuel tanks and fuel system components to local rotorcraft structure, whether frangible or locally deformable, must be designed such that its separation or relative local deformation will occur without rupture or local tear-out of the fuel tank or fuel system components that will cause fuel leakage. The ultimate strength of frangible or deformable attachments must be as follows:

(1) The load required to separate a frangible attachment from its support structure, or deform a locally deformable attachment relative to its support structure, must be between 25 and 50 percent of the minimum ultimate load (ultimate strength) of the weakest component in the attached system. In no case may the load be less than 300 pounds.

(2) A frangible or locally deformable attachment must separate or locally deform as intended

areas and from all potential ignition sources.

(f) *Other basic mechanical design criteria.* Fuel tanks, fuel lines, electrical wires, and electrical devices must be designed, constructed, and installed, as far as practicable, to be crash resistant.

(g) *Rigid or Semirigid fuel tanks.* Rigid or semirigid fuel tank or bladder walls must be impact and tear resistant.]

[(Amdt. 27–30, Eff. 11/2/94)]

§ 27.953 Fuel system independence.

(a) Each fuel system for multiengine rotorcraft must allow fuel to be supplied to each engine through a system independent of those parts of each system supplying fuel to other engines. However, separate fuel tanks need not be provided for each engine.

(b) If a single fuel tank is used on a multiengine rotorcraft, the following must be provided:

(1) Independent tank outlets for each engine, each incorporating a shutoff valve at the tank. This shutoff valve may also serve as the firewall shutoff valve required by § 27.995 if the line between the valve and the engine compartment does not contain a hazardous amount of fuel that can drain into the engine compartment.

(2) At least two vents arranged to minimize the probability of both vents becoming obstructed simultaneously.

(3) Filler caps designed to minimize the probability of incorrect installation or inflight loss.

(4) A fuel system in which those parts of the system from each tank outlet to any engine are independent of each part of each system supplying fuel to other engines.

27.954 Fuel system lightning protection.

The fuel system must be designed and arranged to prevent the ignition of fuel vapor within the system by—

(a) Direct lightning strikes to areas having a high probability of stroke attachment;

(b) Swept lightning strokes to areas where swept strokes are highly probable; or

the rotorcraft including, as applicable, the fuel required to operate the engine(s) under the test conditions required by § 27.927. Unless equivalent methods are used, compliance must be shown by test during which the following provisions are met except that combinations of conditions which are shown to be improbable need not be considered.

(1) The fuel pressure, corrected for critical accelerations, must be within the limits specified by the engine type certificate data sheet.

(2) The fuel level in the tank may not exceed that established as unusable fuel supply for the tank under § 27.959, plus the minimum additional fuel necessary to conduct the test.

(3) The fuel head between the tank outlet and the engine inlet must be critical with respect to rotorcraft flight attitudes.

(4) The critical fuel pump (for pump-fed systems) is installed to produce (by actual or simulated failure) the critical restriction to fuel flow to be expected from pump failure.

(5) Critical values of engine rotation speed, electrical power, or other sources of fuel pump motive power must be applied.

(6) Critical values of fuel properties which adversely affect fuel flow must be applied.

(7) The fuel filter required by § 27.997 must be blocked to the degree necessary to simulate the accumulation of fuel contamination required to activate the indicator required by § 27.1305(q).

(b) *Fuel transfer systems.* If normal operation of the fuel system requires fuel to be transferred to an engine feed tank, the transfer must occur automatically via a system which has been shown to maintain the fuel level in the engine feed tank within acceptable limits during flight or surface operation of the rotorcraft.

(c) *Multiple fuel tanks.* If an engine can be supplied with fuel from more than one tank, the fuel systems must, in addition to having appropriate manual switching capability, be designed to prevent interruption of fuel flow to that engine, without attention by the flightcrew, when any tank supply fuel to that engine is depleted of usable fuel during normal operation, and any other tank that normally the first evidence of malfunction occurs under the most adverse fuel feed condition occurring under any intended operations and flight maneuvers involving that tank.

§ 27.961 Fuel system hot weather operation.

Each suction lift fuel system and other fuel systems with features conducive to vapor formation must be shown by test to operate satisfactorily (within certification limits) when using fuel at a temperature of 110° F under critical operating conditions including, if applicable, the engine operating conditions defined by § 27.927(b)(1) and (b)(2).

(Amdt. 27–23, Eff. 10/3/88)

§ 27.963 Fuel tanks: General.

(a) Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads to which it may be subjected in operation.

(b) Each fuel tank of 10 gallons or greater capacity must have internal baffles, or must have external support to resist surging.

(c) Each fuel tank must be separated from the engine compartment by a firewall. At least one-half inch of clear airspace must be provided between the tank and the firewall.

(d) Spaces adjacent to the surfaces of fuel tanks must be ventilated so that fumes cannot accumulate in the tank compartment in case of leakage. If two or more tanks have interconnected outlets, they must be considered as one tank, and the airspaces in those tanks must be interconnected to prevent the flow of fuel from one tank to another as a result of a difference in pressure between those airspaces.

(e) The maximum exposed surface temperature of any component in the fuel tank must be less, by a safe margin as determined by the Administrator, than the lowest expected autoignition temperature of the fuel or fuel vapor in the tank. Compliance with this requirement must be shown under all operating conditions and under all failure § 27.952, and must be adequate to withstand loads and abrasions to be expected in personnel compartments.

[(g) Each flexible fuel tank bladder or liner must be approved or shown to be suitable for the particular application and must be puncture resistant. Puncture resistance must be shown by meeting the TSO–C80, paragraph 16.0, requirements using a minimum puncture force of 370 pounds.

[(h) Each integral fuel tank must have provisions for inspection and repair of its interior.]

(Amdt. 27–23, Eff. 10/3/88); [(Amdt. 27–30, Eff. 11/2/94)]

§ 27.965 Fuel tank tests.

(a) Each fuel tank must be able to withstand the applicable pressure tests in this section without failure or leakage. If practicable, test pressures may be applied in a manner simulating the pressure distribution in service.

(b) Each conventional metal tank, nonmetallic tank with walls that are not supported by the rotorcraft structure, and integral tank must be subjected to a pressure of 3.5 p.s.i. unless the pressure developed during maximum limit acceleration or emergency deceleration with a full tank exceeds this value, in which case a hydrostatic head, or equivalent test, must be applied to duplicate the acceleration loads as far as possible. However, the pressure need not exceed 3.5 p.s.i. on surfaces not exposed to the acceleration loading.

(c) Each nonmetallic tank with walls supported by the rotorcraft structure must be subjected to the following tests:

(1) A pressure test of at least 2.0 p.s.i. This test may be conducted on the tank alone in conjunction with the test specified in paragraph (c)(2) of this section.

(2) A pressure test, with the tank mounted in the rotorcraft structure, equal to the load developed by the reaction of the contents, with the tank full, during maximum limit acceleration or emergency deceleration. However, the pressure need not exceed 2.0 p.s.i. on surfaces not exposed to the acceleration loading.

25 hours while two-thirds full of any suitable fluid. The amplitude of vibration may not be less than one thirty-second of an inch, unless otherwise substantiated.

(3) The test frequency of vibration must be as follows:

(i) If no frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, the test frequency of vibration, in number of cycles per minute must, unless a frequency based on a more rational calculation is used, be the number obtained by averaging the maximum and minimum power-on engine speeds (r.p.m.) for reciprocating engine powered rotorcraft or 2,000 c.p.m. for turbine engine powered rotorcraft.

(ii) If only one frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, that frequency of vibration must be the test frequency.

(iii) If more than one frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, the most critical of these frequencies must be the test frequency.

(4) Under paragraphs (d)(3)(ii) and (iii) of this section, the time of test must be adjusted to accomplish the same number of vibration cycles as would be accomplished in 25 hours at the frequency specified in paragraph (d)(3)(i) of this section.

(5) During the test, the tank assembly must be rocked at the rate of 16 to 20 complete cycles per minute through an angle of 15 degrees on both sides of the horizontal (30 degrees total), about the most critical axis, for 25 hours). If motion about more than one axis is likely to be critical, the tank must be rocked about each critical axis for 12½ hours.

(Amdt. 27–12, Eff. 5/2/77)

(3) If flexible tank liners are used, they must be supported so that it is not necessary for them to withstand fluid loads; and

(4) Each interior surface of tank compartments must be smooth and free of projections that could cause wear of the liner unless—

(i) There are means for protection of the liner at those points; or

(ii) The construction of the liner itself provides such protection.

(b) Any spaces adjacent to tank surfaces must be adequately ventilated to avoid accumulation of fuel or fumes in those spaces due to minor leakage. If the tank is in a sealed compartment, ventilation may be limited to drain holes that prevent clogging and excessive pressure resulting from altitude changes. If flexible tank liners are installed, the venting arrangement for the spaces between the liner and its container must maintain the proper relationship to tank vent pressures for any expected flight condition.

(c) The location of each tank must meet the requirements of § 27.1185(a) and (c).

(d) No rotorcraft skin immediately adjacent to a major air outlet from the engine compartment may act as the wall of the integral tank.]

[(Amdt. 27–30, Eff. 11/2/94)]

§ 27.969 Fuel tank expansion space.

Each fuel tank or each group of fuel tanks with interconnected vent systems must have an expansion space of not less than 2 percent of the tank capacity). It must be impossible to fill the fuel tank expansion space inadvertently with the rotorcraft in the normal ground attitude.

(Amdt. 27–23, Eff. 10/3/88)

§ 27.971 Fuel tank sump.

(a) Each fuel tank must have a drainable sump with an effective capacity in any ground attitude to be expected in service of 0.25 percent of the water will drain from all parts of the tank to the sediment bowl or chamber.

(b) Each sump, sediment bowl, and sediment chamber drain required by the section must comply with the drain provisions of § 27.999(b).

(Amdt. 27–23, Eff. 10/3/88)

§ 27.973 Fuel tank filler connection.

[(a) Each fuel tank filler connection must prevent the entrance of fuel into any part of the rotorcraft other than the tank itself during normal operations and must be crash resistant during a survivable impact in accordance with § 27.952(c). In addition—

(1) Each filler must be marked as prescribed in § 27.1557(c)(1);

(2) Each recessed filler connection that can retain any appreciable quantity of fuel must have a drain that discharges clear of the entire rotorcraft; and

(3) Each filler cap must provide a fuel-tight seal under the fluid pressure expected in normal operation and in a survivable impact.

(b) Each filler cap or filler cap cover must warn when the cap is not fully locked or seated on the filler connection.]

[(Amdt. 27–30, Eff. 11/2/94)]

§ 27.975 Fuel tank vents.

(a) Each fuel tank must be vented from the top part of the expansion space so that venting is effective under all normal flight conditions. Each vent must minimize the probability of stoppage by dirt or ice.

(b) [The venting system must be designed to minimize spillage of fuel through the vents to an ignition source in the event of a rollover during landing, ground operation, or a survivable impact, unless a rollover is shown to be extremely remote.]

(Amdt. 27–23, Eff. 10/3/88); [(Amdt. 27–30, Eff. 11/2/94)]

fuel flow or damage any fuel system component.

(b) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line.

(c) The diameter of each strainer must be at least that of the fuel tank outlet.

(d) Each finger strainer must be accessible for inspection and cleaning.

(Amdt. 27–11, Eff. 2/1/77)

FUEL SYSTEM COMPONENTS

§ 27.991 Fuel pumps.

Compliance with § 27.955 may not be jeopardized by failure of—

(a) Any one pump except pumps that are approved and installed as parts of a type certificated engine; or

(b) Any component required for pump operation except, for engine driven pumps, the engine served by that pump.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–23, Eff. 10/3/88)

§ 27.993 Fuel system lines and fittings.

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the rotorcraft between which relative motion could exist must have provisions for flexibility.

(c) Flexible hose must be approved.

(d) Each flexible connection in fuel lines that may be under pressure or subjected to axial loading must use flexible hose assemblies.

(e) No flexible hose that might be adversely affected by high temperatures may be used where excessive temperatures will exist during operation or after engine shutdown.

(Amdt. 27–2, Eff. 2/25/68)

(d) No shutoff valve may be on the engine side of any firewall.

§ 27.997 Fuel strainer or filter.

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of the first fuel system component which is susceptible to fuel contamination, including but not limited to the fuel metering device or an engine positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must—

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Provide a means to remove from the fuel any contaminant which would jeopardize the flow of fuel through rotorcraft or engine fuel system components required for proper rotorcraft fuel system or engine fuel system operation.

(Amdt. 27–9, Eff. 10/31/74); (Amdt. 27–20, Eff. 3/26/84); (Amdt. 27–23, Eff. 10/3/88)

§ 27.999 Fuel system drains.

(a) There must be at least one accessible drain at the lowest point in each fuel system to completely drain the system with the rotorcraft in any ground attitude to be expected in service.

(b) Each drain required by paragraph (a) of this section must—

(1) Discharge clear of all parts of the rotorcraft;

(2) Have manual or automatic means to assure positive closure in the off position; and

(3) Have a drain valve—

OIL SYSTEM

§ 27.1011 Engines: General.

(a) Each engine must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

(b) The usable oil capacity of each system may not be less than the product of the endurance of the rotorcraft under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling. Instead of a rational analysis of endurance and consumption, a usable oil capacity of 1 gallon for each 40 gallons of usable fuel may be used.

(c) The oil cooling provisions for each engine must be able to maintain the oil inlet temperature to that engine at or below the maximum established value. This must be shown by flight tests.

(Amdt. 27–23, Eff. 10/3/88)

§ 27.1013 Oil tanks.

Each oil tank must be designed and installed so that—

(a) It can withstand, without failure, each vibration, inertia, fluid, and structural load expected in operation;

(b) [Reserved]

(c) Where used with a reciprocating engine, it has an expansion space of not less than the greater of 10 percent of the tank capacity or 0.5 gallon, and where used with a turbine engine, it has an expansion space of not less than 10 percent of the tank capacity.

(d) It is impossible to fill the tank expansion space inadvertently with the rotorcraft in the normal ground attitude;

(e) Adequate venting is provided; and

(f) There are means in the filler opening to prevent oil overflow from entering the oil tank compartment.

(Amdt. 27–9, Eff. 10/31/74)

(Amdt. 27–9, Eff. 10/31/74)

§ 27.1017 Oil lines and fittings.

(a) Each oil line must be supported to prevent excessive vibration.

(b) Each oil line connected to components of the rotorcraft between which relative motion could exist must have provisions for flexibility.

(c) Flexible hose must be approved.

(d) Each oil line must have an inside diameter of not less than the inside diameter of the engine inlet or outlet. No line may have splices between connections.

§ 27.1019 Oil strainer or filter.

(a) Each turbine engine installation must incorporate an oil strainer or filter through which all of the engine oil flows and which meets the following requirements:

(1) Each oil strainer or filter that has a bypass must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter completely blocked.

(2) The oil strainer or filter must have the capacity (with respect to operating limitations established for the engine) to ensure that engine oil system functioning is not impaired when the oil is contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine under part 33 of this chapter.

(3) The oil strainer or filter, unless it is installed at an oil tank outlet, must incorporate a means to indicate contamination before it reaches the capacity established in accordance with paragraph (a)(2) of this section.

(4) The bypass of a strainer or filter must be constructed and installed so that the release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.

(5) An oil strainer or filter that has no bypass, except one that is installed at an oil tank outlet,

§ 27.1021 Oil system drains.

A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must—

(a) Be accessible; and

(b) Have manual or automatic means for positive locking in the closed position.

(Amdt. 27–20, Eff. 3/26/84)

[§ 27.1027 Transmissions and gearboxes: General.]

[(a) Pressure lubrication systems for transmissions and gearboxes must comply with the engine oil system requirements of §§ 27.1013 (except paragraph (c)), 27.1015, 27.1017, 27.1021, and 27.1337(d).

[(b) Each pressure lubrication system must have an oil strainer or filter through which all of the lubricant flows and must—

[(1) Be designed to remove from the lubricant any contaminant which may damage transmission and drive system components or impede the flow of lubricant to a hazardous degree;

[(2) Be equipped with a means to indicate collection of contaminants on the filter or strainer at or before opening of the bypass required by paragraph (b)(3) of this section; and

[(3) Be equipped with a bypass constructed and installed so that—

[(i) The lubricant will flow at the normal rate through the rest of the system with the strainer of filter completely blocked; and

[(ii) The release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flowpath.

[(c) For each lubricant tank or sump outlet supplying lubrication to rotor drive systems and rotor drive system components, a screen must be provided to prevent entrance into the lubrication system of any object that might obstruct the flow of lubricant from the outlet to the filter required by paragraph (b) of this section. The requirements

§ 27.1041 General.

(a) Each powerplant cooling system must be able to maintain the temperatures of powerplant components within the limits established for these components under critical surface (ground or water) and flight operating conditions for which certification is required and after normal shutdown. Powerplant components to be considered include but may not be limited to engines, rotor drive system components, auxiliary power units, and the cooling or lubricating fluids used with these components.

(b) Compliance with paragraph (a) of this section must be shown in tests conducted under the conditions prescribed in that paragraph.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–23, Eff. 10/3/88)

§ 27.1043 Cooling tests.

(a) *General.* For the tests prescribed in § 27.1041(b), the following apply:

(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature specified in paragraph (b) of this section, the recorded powerplant temperatures must be corrected under paragraphs (c) and (d) of this section unless a more rational correction method is applicable.

(2) No corrected temperature determined under paragraph (a)(1) of this section may exceed established limits.

(3) For reciprocating engines, the fuel used during the cooling tests must be of the minimum grade approved for the engines, and the mixture settings must be those normally used in the flight stages for which the cooling tests are conducted.

(4) The test procedures must be as prescribed in § 27.1045.

(b) *Maximum ambient atmospheric temperature.* A maximum ambient atmospheric temperature corresponding to sea level conditions of at least 100 degrees F must be established. The assumed temperature lapse rate is 3.6 degrees F per thousand feet of altitude above sea level until a temperature of −69.7 degrees F is reached, above which altitude the temperature is considered constant at −69.7 degrees F. However, for winterization installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea level conditions of less than 100 degrees F.

its are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

(d) *Correction factor for cylinder barrel temperatures.* Cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–14, Eff. 3/1/78)

§ 27.1045 Cooling test procedures.

(a) *General.* For each stage of flight, the cooling tests must be conducted with the rotorcraft

(1) In the configuration most critical for cooling; and

(2) Under the conditions most critical for cooling.

(b) *Temperature stabilization.* For the purpose of the cooling tests, a temperature is "stabilized" when its rate of change is less than 20° F. per minute. The following component and engine fluid temperature stabilization rules apply:

(1) For each rotorcraft, and for each stage of flight—

(i) The temperatures must be stabilized under the conditions from which entry is made into the stage of flight being investigated; or

(ii) if the entry condition normally does not allow temperatures to stabilize, operation through the fuel entry condition must be conducted before entry into the stage of flight being investigated in order to allow the temperatures to attain their natural levels at the time of entry.

(2) For each helicopter during the takeoff stage of flight, the climb at takeoff power must be preceded by a period of hover during which the temperatures are stabilized.

INDUCTION SYSTEM

§ 27.1091 Air induction.

(a) The air induction system for each engine must supply the air required by that engine under the operating conditions and maneuvers for which certification is requested.

(b) Each cold air induction system opening must be outside the cowling if backfire flames can emerge.

(c) If fuel can accumulate in any air induction system, that system must have drains that discharge fuel—

(1) Clear of the rotorcraft; and

(2) Out of the path of exhaust flames.

[(d)] For turbine engine powered rotorcraft—

(1)There must be means to prevent hazardous quantities of fuel leakage or overflow from drain, vents, or other components of flammable fluid systems from entering the engine intake system; and

(2) The air inlet ducts must be located or protected so as to minimize the ingestion of foreign matter during takeoff, landing, and taxiing.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–23, Eff. 10/3/88)

§ 27.1093 Induction system icing protection.

(a) *Reciprocating engines.* Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of 300 F., and with the engines at 75 percent of maximum continuous power—

(1) Each rotorcraft with sea level engines using conventional venturi carburetors has a preheater that can provide a heat rise of 90° F.;

(2) Each rotorcraft with sea level engines using carburetors tending to prevent icing has a sheltered alternate source of air, and that the preheat supplied to the alternate air intake is not less

(i) 100° F., or

(ii) If a fluid deicing system is used, at least 40° F.

(b) *Turbine engines.*

(1) [It must be shown that each turbine engine and its air inlet system can operate throughout the flight power range of the engine (including idling)—

[(i) Without accumulating ice on engine or inlet system components that would adversely affect engine operation or cause a serious loss of power under the icing conditions specified in appendix C of part 29 of this chapter; and

[(ii) In snow, both falling and blowing, without adverse effect on engine operation, within the limitations established for the rotorcraft.]

(2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30° F (between −9° and −1° C) and has a liquid water content not less than 0.3 grams per cubic meter in the form of drops having a mean effective diameter of not less than 20 microns, followed by momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

(c) *Supercharged reciprocating engines.* For each engine having superchargers to pressurize the air before it enters the carburetor, the heat rise in the air caused by that supercharging at any altitude may be utilized in determining compliance with paragraph (a) of this section if the heat rise utilized is that which will be available, automatically, for the applicable altitude and operating condition because of supercharging.

(Amdt. 27–9, Eff. 10/31/74); (Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–20, Eff. 3/26/84); (Amdt. 27–23, Eff. 10/3/88)

(c) Exhaust gases must discharge clear of the engine air intake, fuel system components, and drains;

(d) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapors must be located or shielded so that leakage from any system carrying flammable fluids or vapors will not result in a fire caused by impingement of the fluids or vapors on any part of the exhaust system including shields for the exhaust system.

(e) Exhaust gases may not impair pilot vision at night due to glare; and

(f) If significant traps exist, each turbine engine exhaust system must have drains discharging clear of the rotorcraft, in any normal ground and flight attitudes, to prevent fuel accumulation after the failure of an attempted engine start.

(g) Each exhaust heat exchanger must incorporate means to prevent blockage of the exhaust port after any internal heat exchanger failure.

(Amdt. 27–12, Eff. 5/2/77)

§ 27.1123 Exhaust piping.

(a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.

(b) Exhaust piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operations.

(c) Exhaust piping connected to components between which relative motion could exist must have provisions for flexibility.

(Amdt. 27–11, Eff. 2/1/77)

POWERPLANT CONTROLS AND ACCESSORIES

§ 27.1141 Powerplant controls: General.

(a) Powerplant controls must be located and arranged under § 27.777 and marked under § 27.1555.

(b) Each flexible powerplant control must be approved.

the case of fuel valves suitable index provisions, in the open and closed position; and

(2) For power-assisted valves, a means to indicate to the flight crew when the valve—

(i)Is in the fully open or fully closed position; or

(ii) is moving between the fully open and fully closed position.

(【e】) For turbine engine powered rotorcraft, no single failure or malfunction, or probable combination thereof, in any powerplant control system may cause the failure of any powerplant function necessary for safety.

(Amdt. 27–12, Eff. 5/2/77); (Amdt. 27–23, Eff. 10/3/88); 【(Amdt. 27–33, Eff. 8/8/96)】

§ 27.1143 Engine controls.

(a) There must be a separate power control for each engine.

(b) Power controls must be grouped and arranged to allow—

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each power control must provide a positive and immediately responsive means of controlling its engine.

(d) If a power control incorporates a fuel shutoff feature, the control must have a means to prevent the inadvertent movement of the control into the shutoff position. The means must—

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shutoff position.

【(e) For rotorcraft to be certificated for a 30-second OEI power rating, a means must be provided to automatically activate and control the 30-second OEI power and prevent any engine from exceeding the installed engine limits associated with the 30-second OEI power rating approved for the rotorcraft.】

(Amdt. 27–11, Eff. 2/1/77); (Amdt. 27–23, Eff. 10/3/88); 【(Amdt. 27–29, Eff. 10/17/94)】

(Amdt. 27–12, Eff. 5/2/77)

§ 27.1147 Mixture controls.

If there are mixture controls, each engine must have a separate control and the controls must be arranged to allow—

(a) Separate control of each engine; and

(b)Simultaneous control of all engines.

[§ 27.1151 Rotor brake controls.

[(a) It must be impossible to apply the rotor brake inadvertently in flight.

[(b) There must be means to warn the crew if the rotor brake has not been completely released before takeoff.]

[(Amdt. 27–33, Eff. 8/8/96)]

§ 27.1163 Powerplant accessories.

(a) Each engine-mounted accessory must—

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed in such a way as to prevent contamination of the engine oil system and the accessory system.

(b) Unless other means are provided, torque limiting means must be provided for accessory drives located on any component of the transmission and rotor drive system to prevent damage to these components from excessive accessory load.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–20, Eff. 3/26/84); (Amdt. 27–23, Eff. 10/3/88)

POWERPLANT FIRE PROTECTION

§ 27.1183 Lines, fittings, and components.

(a) Except as provided in paragraph (b) of this section, each line, fitting, and other component carrying flammable fluid in any area subject to engine fire conditions must be fire resistant, except that flammable fluid tanks and supports which are

(b) Paragraph (a) does not apply to—

(1) Lines, fittings, and components which are already approved as part of a type certificated engine; and

(2) Vent and drain lines, and their fittings, whose failure will not result in, or add to, a fire hazard.

(c) Each flammable fluid drain and vent must discharge clear of the induction system air inlet.

(Amdt. 27–1, Eff. 6/4/67); (Amdt. 27–9, Eff. 10/31/74); (Amdt. 27–20, Eff. 3/26/84)

§ 27.1185 Flammable fluids.

(a) Each fuel tank must be isolated from the engines by a firewall or shroud.

(b) Each tank or reservoir, other than a fuel tank, that is part of a system containing flammable fluids or gases must be isolated from the engine by a firewall or shroud, unless the design of the system, the materials used in the tank and its supports, the shutoff means, and the connections, lines and controls provide a degree of safety equal to that which would exist if the tank or reservoir were isolated from the engines.

(c) There must be at least one-half inch of clear airspace between each tank and each firewall or shroud isolating that tank, unless equivalent means are used to prevent heat transfer from each engine compartment to the flammable fluid.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–11, Eff. 2/1/77)

§ 27.1187 Ventilation.

Each compartment containing any part of the powerplant installation must have provision for ventilation.

§ 27.1189 Shutoff means.

(a) There must be means to shut off each line carrying flammable fluids into the engine compartment, except—

(1) Lines, fittings, and components forming an integral part of an engine;

it possible for the crew to reopen it in flight after it has been closed.

(c) Each shutoff valve and its control must be designed, located, and protected to function properly under any condition likely to result from an engine fire.

(Amdt. 27–2, Eff. 2/25/68); (Amdt. 27–20, Eff. 3/26/84); (Amdt. 27–23, Eff. 10/3/88)

§ 27.1191 Firewalls.

(a) Each engine, including the combustor, turbine, and tailpipe sections of turbine engines must be isolated by a firewall, shroud, or equivalent means, from personnel compartments, structures, controls, rotor mechanisms, and other parts that are—

(1) Essential to a controlled landing; and

(2) Not protected under § 27.861.

(b) Each auxiliary power unit and combustion heater, and any other combustion equipment to be used in flight, must be isolated from the rest of the rotorcraft by firewalls, shrouds, or equivalent means.

(c) In meeting paragraphs (a) and (b) of this section, account must be taken of the probable path of a fire as affected by the airflow in normal flight and in autorotation.

(d) Each firewall and shroud must be constructed so that no hazardous quantity of air, fluids, or flame can pass from any engine compartment to other parts of the rotorcraft.

(e) Each opening in the firewall or shroud must be sealed with close-fitting, fireproof grommets, bushings, or firewall fittings.

(f) Each firewall and shroud must be fireproof and protected against corrosion.

(Amdt. 27–2, Eff. 2/25/68)

compartment in the normal ground and flight attitudes.

(c) No drain may discharge where it might cause a fire hazard.

(d) Each cowling and engine compartment covering must be at least fire resistant.

(e) Each part of the cowling or engine compartment covering subject to high temperatures due to its nearness to exhaust system parts or exhaust gas impingement must be fireproof.

(f) A means of retaining each openable or readily removable panel, cowling, or engine or rotor drive system covering must be provided to preclude hazardous damage to rotors or critical control components in the event of structural or mechanical failure of the normal retention means, unless such failure is extremely improbable.

(Amdt. 27–23, Eff. 10/3/88)

§ 27.1194 Other surfaces.

All surfaces aft of, and near, powerplant compartments, other than tail surfaces not subject to heat, flames, or sparks emanating from a powerplant compartment, must be at least fire resistant.

(Amdt. 27–2, Eff. 2/25/68)

§ 27.1195 Fire detector systems.

Each turbine engine powered rotorcraft must have approved quick-acting fire detectors in numbers and locations insuring prompt detection of fire in the engine compartment which cannot be readily observed in flight by the pilot in the cockpit.

(Amdt. 27–5, Eff. 4/23/71)

[C27.1 General.

A small multiengine rotorcraft may not be type certificated for Category A operation unless it meets the design installation and performance requirements contained in this appendix in addition to the requirements of this part.

[C27.2 Applicable part 29 sections.

The following sections of part 29 of this chapter must be met in addition to the requirements of this part:

29.45(a) and (b)(2)—General.

29.49(a)—Performance at minimum operating speed.

29.51—Takeoff data: General.

29.53—Takeoff: Category A.

29.55—Takeoff decision point: Category A.

29.59—Takeoff path: Category A.

29.60—Elevated heliport takeoff path: Category A.

29.61—Takeoff distance: Category A.

29.62—Rejected takeoff: Category A.

29.64—Climb: General.

29.65(a)—Climb: AEO.

29.67(a)—Climb: OEI.

29.75—Landing: General.

29.77—Landing decision point: Category A.

29.79—Landing: Category A.

29.81—Landing distance (Ground level sites): Category A.

29.85—Balked landing: Category A.

29.87(a)—Height-velocity envelope.

29.547(a) and (b)—Main and tail rotor structure.

29.861(a)—Fire protection of structure, controls, and other parts.

29.901(c)—Powerplant: Installation.

29.903(b) (c) and (e)—Engines.

29.908(a)—Cooling fans.

29.917(b) and (c)(1)—Rotor drive system: Design.

29.927(c)(1)—Additional tests.

29.953(a)—Fuel system independence.

29.1027(a)—Transmission and gearboxes: General.

29.1045(a)(1), (b), (c), (d), and (f)—Climb cooling test procedures.

29.1047(a)—Takeoff cooling test procedures.

29.1181(a)—Designated fire zones: Regions included.

29.1187(e)—Drainage and ventilation of fire zones.

29.1189(c)—Shutoff means.

29.1191(a)(1)—Firewalls.

29.1193(e)—Cowling and engine compartment covering.

29.1195(a) and (d)—Fire extinguishing systems (one shot).

29.1197—Fire extinguishing agents.

29.1199—Extinguishing agent containers.

29.1201—Fire extinguishing system materials.

29.1305(a) (6) and (b)—Powerplant instruments.

29.1309(b)(2) (i) and (d)—Equipment, systems, and installations.

29.1323(c)(1)—Airspeed indicating system.

29.1331(b)—Instruments using a power supply.

29.1351(d)(2)—Electrical systems and equipment: General (operation without normal electrical power).

29.1587(a)—Performance information.

NOTE: In complying with the paragraphs listed in paragraph C27.2 above, relevant material in the AC "Certification of Transport Category Rotorcraft" should be used.]

[(Amdt. 27–33, Eff. 8/8/96)]